Space Weather Technical Forecast

Issued on Friday, 20 May 2022 at 01:23 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: R1-R2 Radio Blackouts likely. Chance R3 Radio blackouts from AR3014.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate in the last 24 hours with three M-class flares observed, the largest of which was M5.6 peaking 0714 UTC from AR3017 Cro/Beta. This is a small region to the southwest of the larger and more complex main sunspot group AR3014 Ekc/Beta-Gamma-Delta, although these two regions likely have some magnetic connection. The larger region has continued to show some slow growth, with the trailer and leader penumbral areas now showing signs of merging. Despite this, flare activity of this region has remained somewhat muted so far, although the other two observed M-flares originated from this region. The five other regions on the disc remain much smaller, and are either stable or showing signs of declining. There were no Earth-directed CMEs observed.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by ACE and DSCOVR at L1 remained elevated to slightly elevated, with a small enhancement at 19/1318 UTC, perhaps associated with the arrival of the fast wind of CH82, but also potentially related to a passing weak CME. The solar wind speed was around 450-550km/s, with a slight rising trend towards the end of the period. The solar wind density was average, while the interplanetary magnetic field (IMF) Bt, also exhibited an enhancement from weak values of 5-6nT to 10nT at 19/1318 UTC. The north-south component remained weak however, varying between +6 and -6nT. The phi angle was mainly positive (away from the Sun). Geomagnetic activity was Quite to Unsettled.

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV) has been at Background levels through the last 24 hours. The high energy electron flux (greater than 2 MeV) was at Normal Background levels, with the corresponding electron fluence well below the Active (1e8 integrated pfu). Observed fluence at 20/0000 UTC was 2.84e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is Likely to be Moderate, with further M-class flares, and a Chance of an isolated Strong-class flare (R3 Radio Blackout). The main source of the activity is likely to be from AR3014, although some flaring is also possible from AR3017 with a lower chance from the other five regions.

Solar Wind / Geomagnetic Activity: A weak CME was observed which could have originated from AR3015 at 17/0510 UTC. This has been assessed as most likely passing behind Earth's orbit on 20 May, but may give a glancing blow but with very low confidence. Slightly elevated to elevated solar winds are expected to persist through much of the period, as further coronal hole influence is anticipated from CH82. Geomagnetic activity is forecast to be Quiet with isolated Unsettled spells, and a chance of becoming Unsettled to Active on day 1 mainly due to any ongoing effects of CH82.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) is expected to be at Background levels during this period, but with a Slight Chance of flux reaching S1, should any notable flares occur. The high energy electron flux (greater than 2 MeV) is

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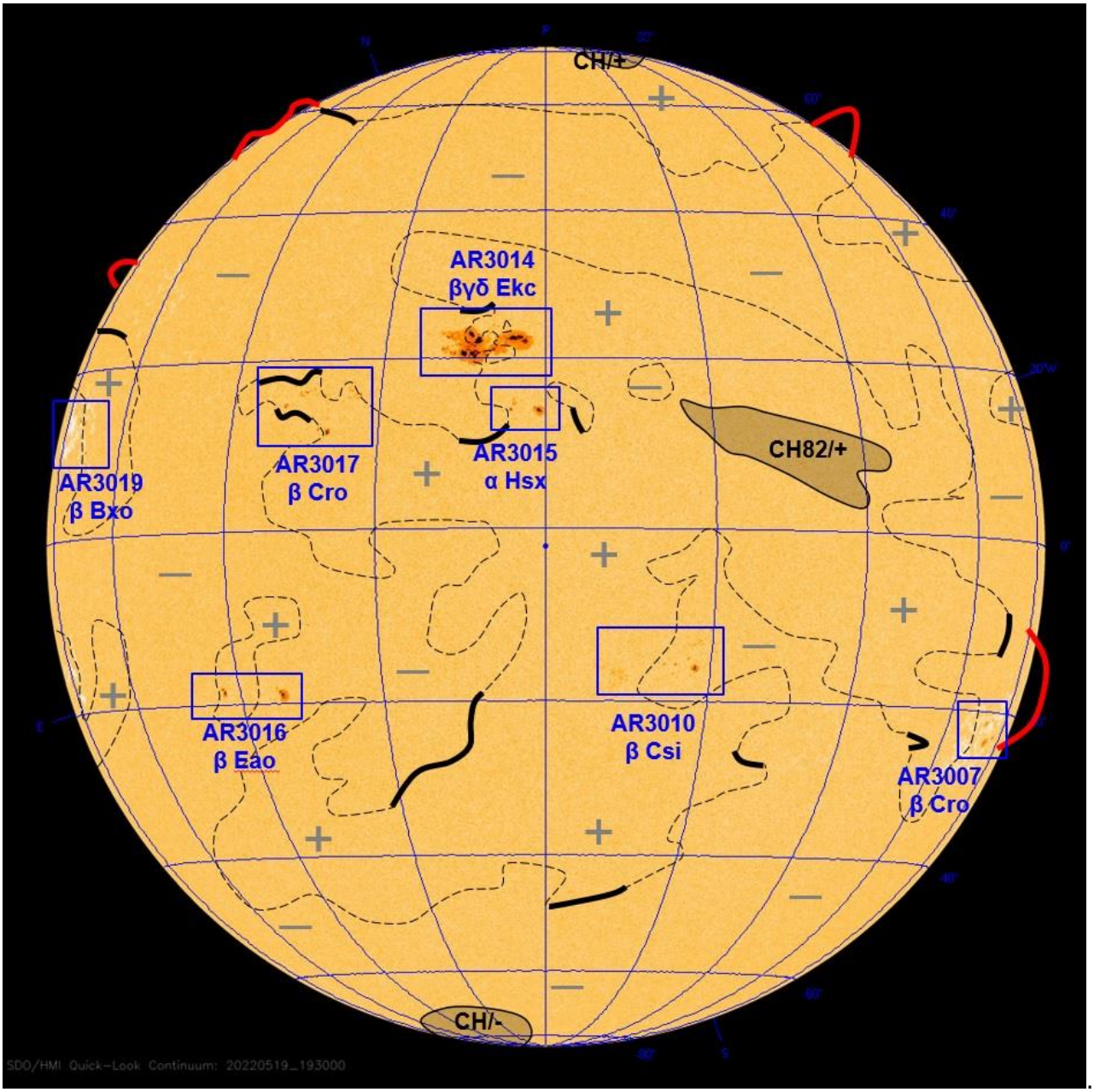
forecast to remain at Background levels at first, but may rise over the next few days, with an increased chance of the diurnal peak reaching High levels later in the period due to fast wind effects. The 24-hour electron fluence is expected to remain below the Active (1e8 integrated pfu) threshold during the forecast period, but with a likely rising trend.

Figure 1. Solar Analysis Valid 19/2000.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

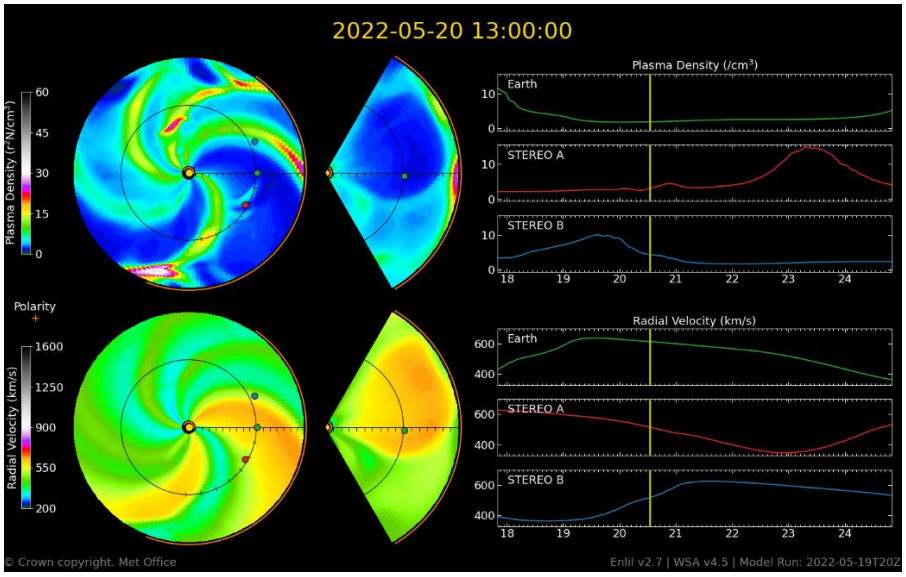
A weak CME observed in coronagraph imagery during 17 May likely from AR3015 at 17/0510 UTC. This has been assessed as most likely passing behind Earth's orbit on day 1 (20th), however confidence is very low. As such, there is a very slight chance of a glancing blow, although this is unlikely to have a significant influence on the geomagnetic forecast. There is also a chance that this CME has already passed on the 19th, and was the source of a weak enhancement that was observed.

Solar winds are currently slightly elevated to elevated, likely due to the fast wind of CH82, however further influence from this feature is possible through day 1 (20th) before easing day 2 (21st) onward. No other significant enhancement to the solar wind or geomagnetic activity is forecast.

Geomagnetic activity is forecast to be Quiet with isolated Unsettled spells, and a chance of becoming Unsettled to Active on day 1 due to any ongoing effects of CH82 and the very slight chance of a glancing CME.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	1	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: Enlil showing weak CME missing just behind Earth.



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Radio Blackouts - X-Ray Flares:

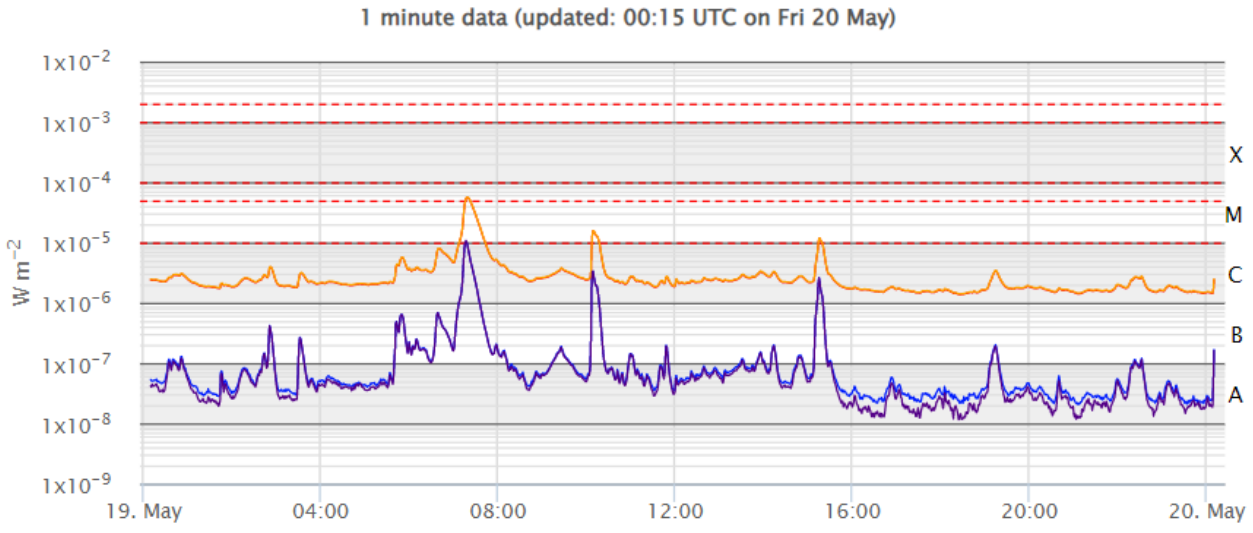
Solar Activity is currently Moderate with three M-class flares observed in the last 24 hours, peaking M5.6 from AR3017 Cro/Beta. This is a small but rather spread-out active region, to the southeast of large region AR3014 Ekc/Beta-Gamma-Delta, and appears to be magnetically connected to this region.

AR3014 remains the most likely source of flaring. This is a large sunspot in the northern central disc, and has continued to show some very gradual growth, with leader and trailer penumbra showing signs of merging into a single large area. There are also a number of delta spots within the region. The most marked is between the trailer and a positive umbral area to the north of it, but also small deltas are visible to the southwest of the trailer and amongst the intermediate regions as penumbral development merged the leader and trailer. There are also indications of increasing complexity and instability, especially given the east-west polarity separation line around the trailer. Significant flaring is considered likely from this region, despite a lack of notable flares so far.

There are a total of seven regions on the Earth-facing disc, however all other regions remain much smaller, except possibly AR3017 which has shown some very limited growth and will need monitoring for any further development. Activity is likely to persist at Moderate, with further M-class flares, with a chance of rising to high with isolated X-class flares from AR3014.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	70	70	70	70
Very Active	R3 to R5 X Class	No	25	20	15	15

Figure 3: GOES-16/17 X-ray Flux



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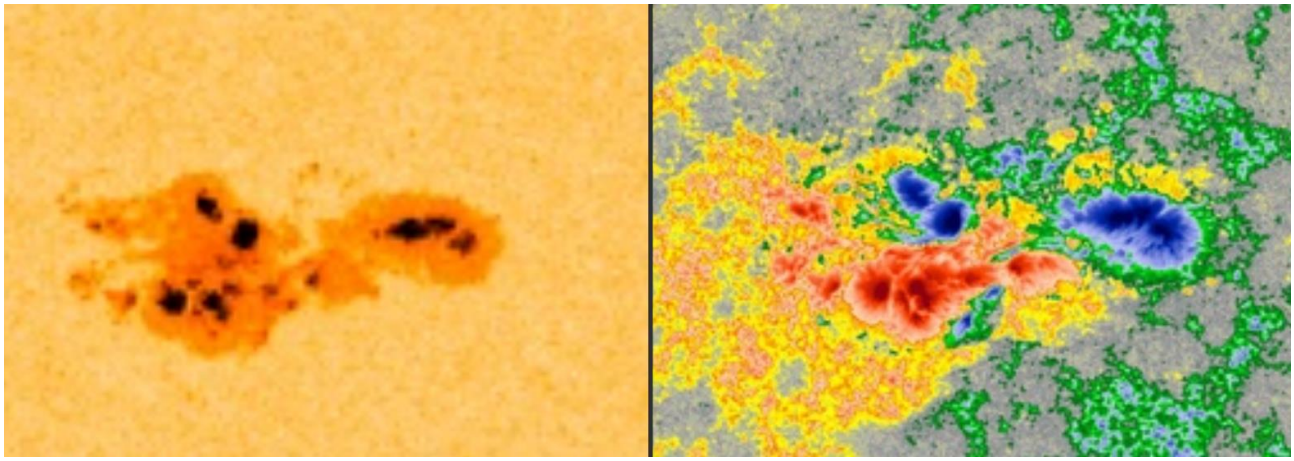
Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) is at background levels and is expected to remain at that level through the period. However, there is a slight chance of an S1 or greater event during the forecast period. This is mainly from AR3014, which remains a complex and large sunspot region that will soon move into the western hemisphere. M-class flares are likely from this region, with a chance of X-class flares.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: SDO HMI-Intensitygram and Magnetogram of AR3014



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High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2 MeV) as measured by GOES-16 at GEO is currently at background to moderate levels, but may rise over the next few days as fast winds of CH82 ease. This may give a chance of flux levels reaching High (1000 pfu) levels later in the period.

The corresponding electron fluence is likely to show an upward trend through the period, however on balance will most likely continue below the Active (1e8 integrated pfu) threshold. This is reflected by current REFM output, although this is currently trending too high on day 2 and 3 (21st and 22nd).

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	1	5	5
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 5: GOES-16 >2MeV Electron Flux and fluence with REFM

NOTE: Our REFM model has been upgraded and has changed in appearance. The two main changes are the option to include a recurrence graph, which superimposes observations from the last solar rotation onto the current solar rotation (each plot is the observation from T-minus 28 days). Recurrence is used as a guide to what can be expected in the coming days assuming no difference in solar features, and has low accuracy in certain situations but good accuracy in others (such as recurring coronal holes). The other change is the cadence of REFM forecast fluence data has been reduced past day 1 to only one value per day. The cadence remains 3-hourly for the first 24 hours.

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